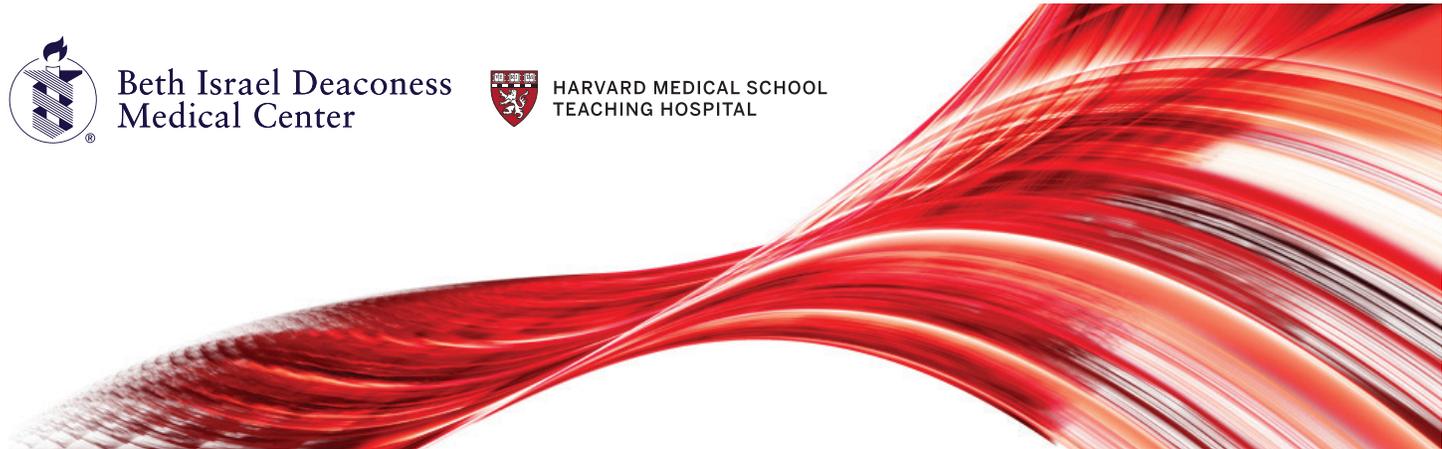




Beth Israel Deaconess  
Medical Center



HARVARD MEDICAL SCHOOL  
TEACHING HOSPITAL



INNOVATION,  
DESIGN, AND  
EMERGING  
ALLIANCES IN  
SURGERY

# IDEAS™

APRIL 5, 2014  
BOSTON, MA



**IDEAS™**  
SURGICAL ROBOTICS:  
FROM PRINCIPLES TO PRACTICE

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## WELCOME TO THE FOURTH ANNUAL IDEAS SYMPOSIUM

AS THE NAME SUGGESTS, **IDEAS** FOSTERS AND PROVIDES AN INTERACTIVE FORUM FOR INNOVATION AT THE INTERFACE OF SURGERY AND OTHER DISCIPLINES—WHETHER THE SOCIAL, BIOLOGICAL, OR PHYSICAL SCIENCES—WITH THE GOAL OF IMPROVING THE LIVES OF PATIENTS WORLDWIDE.

THIS YEAR'S SYMPOSIUM, "SURGICAL ROBOTICS: FROM PRINCIPLES TO PRACTICE," IS A UNIQUE EVENT THAT BRINGS TOGETHER SURGEONS, ENGINEERS, AND THOUGHT LEADERS FROM ACROSS THE UNITED STATES AND EUROPE. OUR SPEAKERS WILL SHARE CUTTING-EDGE IDEAS AND RESEARCH THAT WE HOPE WILL SPARK INNOVATION, ORIGINAL CONCEPTS, AND NOVEL IDEAS.

TOPICS WILL INCLUDE GOVERNMENT PRIORITIES IN ROBOTICS, MEDICAL SIMULATION AND TRAINING, BIONICS IN HUMAN PERFORMANCE, AND MORE. THE DAY'S DISCUSSIONS WILL ALSO TOUCH ON THE USE OF ROBOTICS IN CLINICAL PRACTICE, THE BARRIERS TO ITS USE, AND THE NEXT GENERATION OF SURGERY SYSTEMS.

THIS YEAR WE WILL FEATURE AN ENGAGING POSTER SESSION. RELAX AT THE END OF A FULL DAY WITH COMPLIMENTARY COCKTAILS AND HORS D'OEUVRES WHILE LEARNING ABOUT THE CUTTING-EDGE RESEARCH OCCURRING IN THE FIELD OF SURGICAL ROBOTICS. POSTER CATEGORIES INCLUDE: **ROBOTIC-SURGEON INTERFACE, HUMAN-MACHINE REPLACEMENT AND ASSISTIVE BIOPROSTHETICS, AND ROBOTICS IN SURGICAL PRACTICE.**

THANK YOU FOR ATTENDING AND WELCOME TO BOSTON.

Elliot Chaikof, MD, PhD  
Co-Leader

Henrik Christensen, PhD  
Co-Leader





# SURGICAL ROBOTICS: FROM PRINCIPLES TO PRACTICE

PRESENTED BY THE ROBERTA AND STEPHEN R. WEINER  
DEPARTMENT OF SURGERY AT BETH ISRAEL DEACONESS MEDICAL CENTER

## SCHEDULE AT A GLANCE

7:30-8:30 AM	<b>CHECK IN: CONTINENTAL BREAKFAST</b>
8:30-8:35 AM	<b>INTRODUCTION:</b> Co-LEADERS: ELLIOT L. CHAIKOF, MD, PhD, BETH ISRAEL DEACONESS MEDICAL CENTER/HARVARD HENRIK I. CHRISTENSEN, PhD, GEORGIA INSTITUTE OF TECHNOLOGY
8:35-9:25 AM	<b>VIEWS FROM WASHINGTON: US GOVERNMENT PRIORITIES IN ROBOTICS</b> RICHARD M. VOYLES, PhD, PURDUE UNIVERSITY
9:25-10:30 AM	<b>SESSION 1: HUMAN-MACHINE REPLACEMENT AND ASSISTIVE BIOPROSTHETICS</b> >> CAN BIONICS MAKE HUMANS STRONGER, FASTER, AND MORE AGILE? RICHARD MAHONEY, PhD, SRI INTERNATIONAL >> SURGERY AND NEW INTERFACES PIETER ABBEEL, PhD, UNIVERSITY OF CALIFORNIA, BERKELEY >> ROUNDTABLE DISCUSSION
10:30-11:00 AM	<b>BREAK</b>
11:00 AM-12:30 PM	<b>SESSION 2: BLURRING THE ROBOTIC-SURGEON INTERFACE</b> >> THE "LANGUAGE OF SURGERY" AS A BASIS FOR TEACHING AND TRAINING GREGORY D. HAGER, PhD, JOHNS HOPKINS UNIVERSITY >> MEDICAL SIMULATION AND TRAINING PAOLO FIORINI, PhD, UNIVERSITY OF VERONA >> NEXT-GENERATION SURGERY SYSTEMS H. HARRY ASADA, PhD, MASSACHUSETTS INSTITUTE OF TECHNOLOGY >> ROUNDTABLE DISCUSSION
12:30-2:00 PM	<b>BUFFET LUNCH</b>
2:00-3:30 PM	<b>SESSION 3: ROBOTICS IN PRACTICE: REALIZING CLINICALLY MEANINGFUL ADVANCES</b> >> CHALLENGES IN ROBOTIC COLORECTAL SURGERY DEBORAH A. NAGLE, MD, BETH ISRAEL DEACONESS MEDICAL CENTER/HARVARD >> BARRIERS TO ROBOTIC THORACIC SURGERY PATRICK ROSS JR., MD, PhD, OHIO STATE UNIVERSITY >> CRITICAL REQUIREMENTS IN ROBOTIC CANCER SURGERY YUMAN FONG, MD, CITY OF HOPE NATIONAL MEDICAL CENTER >> ROUNDTABLE DISCUSSION
3:30-3:45 PM	<b>DISCUSSION: POSSIBLE FUTURE OPPORTUNITIES/AVENUES</b>
3:45-6:00 PM	<b>POSTER SESSION/COCKTAIL RECEPTION</b>

## IDEAS Co-LEADERS



### ELLIOT L. CHAIKOF, MD, PHD

Beth Israel Deaconess Medical Center/Harvard

Elliot L. Chaikof, MD, PhD, is Chairman of the Roberta and Stephen R. Weiner Department of Surgery at Beth Israel Deaconess Medical Center. He is the Johnson and Johnson Professor of Surgery at Harvard Medical School, associate faculty member of the Wyss Institute for Biologically Inspired Engineering at Harvard University, and a principal faculty member of the Harvard Stem Cell Institute.

Chaikof's basic research interests lie at the interface of medicine and engineering. Leading collaborative research efforts with clinicians, engineers, and biologists, Chaikof has designed new strategies that have advanced the development of engineered living tissues, implantable devices, and artificial organs, as well as cell-based therapies that have helped define the evolving field of regenerative medicine.

Chaikof is the author of more than 250 peer-reviewed publications and the recipient of the 2013 Clemson Award for Applied Research from the Society for Biomaterials.

### HENRIK I. CHRISTENSEN, PHD

Georgia Institute of Technology



Henrik I. Christensen, PhD, is Director of the Robotics Program, holds the KUKA Chair in Robotics, and is Executive Director of the Institute for Robotics and Intelligent Machines at Georgia Institute of Technology.

His main research interests include human-centered robotics, sensory/data fusion, and systems integration.

Christensen received the Engelberger Award in 2011, and received the Boeing Supplier of the Year 2011 award with three other colleagues at Georgia Tech. He has been named Senior Technical Expert at IEEE, elected Secretary of the International Foundation of Robotics Research, and is senior technical lead of the Robotics Technology Consortium, and a board member of the Robot Industry Association. He is also the founder of the NSF Robotics Virtual Organization and a fellow of American Association for the Advancement of Science.

## KEYNOTE PRESENTATION



### VIEWS FROM WASHINGTON: US GOVERNMENT PRIORITIES IN ROBOTICS

#### RICHARD M. VOYLES, PHD

Purdue University

Richard M. Voyles, PhD, is Associate Dean for Research in the College of Technology at Purdue University and Assistant Director of Robotics and Cyber-Physical Systems in the Technology and Innovation Division of the White House Office of Science and Technology Policy. He is the former Program Director for the U.S. National Robotics Initiative, Robust Intelligence, and Innovation Corps programs at the National Science Foundation.

Voyles' research interests include cyber physical systems, robotics, and artificial intelligence. Specifically, he is interested in the development of small, resource-constrained robots and robot teams for non-engineered environments and for gesture-based human/robot interaction. He has additional expertise in sensors and sensor calibration, particularly haptic and force sensors, real-time control, and robotic manipulation.

His industrial experience includes Dart Controls, IBM, Integrated Systems, Inc., and Avanti Optics. He is also a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE), a member of the American Society of Mechanical Engineers, and a member of the American Society for Engineering Education.



# SESSION 1: HUMAN-MACHINE REPLACEMENT AND ASSISTIVE BIOPROSTHETICS

CAN BIONICS MAKE HUMANS STRONGER, FASTER, AND MORE AGILE?

**RICHARD MAHONEY, PHD**

SRI International

Richard Mahoney, PhD, is Director of the robotics program at SRI International. He has more than 20 years of experience in research, development, and the commercialization of health care robotics technology, with a particular emphasis on assistive and therapy applications. At SRI International, Mahoney leads a team focused on the next generation of tools that can improve patient lives and quality of medical care.



Prior to joining SRI International in 2008, Mahoney was General Manager of the U.S. operations of Motorika USA, an early-stage medical device company specializing in technology for occupational therapy and rehabilitation. Previously, he was Director of Business Development for Applied Resources Corporation, and Co-director of the Robotics Laboratory of the Applied Science and Engineering Labs at the University of Delaware and A.I. DuPont Institute.



## SURGERY AND NEW INTERFACES

**PIETER ABBEEL, PHD**

University of California, Berkeley



Pieter Abbeel, PhD, is Assistant Professor of Electrical Engineering and Computer Sciences at University of California, Berkeley. Abbeel's current research focuses on robotics and machine learning with a particular focus on challenges in personal robotics, surgical robotics, and connectomics. His group has developed apprenticeship learning algorithms that have enabled advanced helicopter aerobatics, including maneuvers such as tic-tocs, chaos and auto-rotation, which only exceptional human pilots can perform. His group has also enabled the first end-to-end completion of reliably picking up a crumpled laundry article and folding it.

Abbeel's work has been featured in many popular press outlets, including BBC, *The New York Times*, *MIT Technology Review*, Discovery Channel, *SmartPlanet*, and *Wired*. He has also won various awards, including best paper awards at ICML and ICRA, the Sloan Fellowship, the Air Force Office of Scientific Research Young Investigator Program Award, the Office of Naval Research Young Investigator Program Award, the Darpa Young Faculty Award, the Okawa Foundation award, the TR35, the IEEE Robotics and Automation Society Early Career Award, and the Dick Volz Best U.S. PhD Thesis in Robotics and Automation Award.

## SESSION 2: BLURRING THE ROBOTIC-SURGEON INTERFACE



### THE "LANGUAGE OF SURGERY" AS A BASIS FOR TEACHING AND TRAINING

#### GREGORY D. HAGER, PHD

Johns Hopkins University

Gregory D. Hager, PhD, is Professor and Chair of Computer Science and Deputy Director of the Center for Computer-Integrated Surgical Systems and Technology at Johns Hopkins University. He also directs the Computational Interaction and Robotics Lab in the Laboratory for Computational Sensing and Robotics at Johns Hopkins. He is Vice-Chair of the Computing Community Consortium Council and a member of the International Federation of Robotics Research Board.

Hager's principal areas of research are in computer vision and robotics, and his application interests are in interventional medicine and human-machine systems. He has published almost 300 articles and books in these areas. He was elected a fellow of the IEEE in 2006 for his contributions to vision-based robotics.

### MEDICAL SIMULATION AND TRAINING

#### PAOLO FIORINI, PHD

University of Verona



Paolo Fiorini, PhD, is Professor of Computer Science at the University of Verona in Italy. Fiorini's main research interests are in the area of robotics and advanced teleoperation, including networked robots and haptics. The systems he has designed have found applications in robotic surgery, medical automation, space exploration, logistics, and rehabilitation.

From 1985 to 2000, Fiorini was a staff member at NASA Jet Propulsion Laboratory of California Institute of Technology, where he worked on autonomous and teleoperated systems for space exploration. In 2001, he founded the ALTAIR robotics laboratory, which has been awarded several EU and Italian grants. In 2009, he founded the company Surgical Robotica, whose new surgical robot received CE certification and is now in the process of being industrialized. He has published extensively in refereed journals and conference proceedings and has served on the technical program committees of numerous robotic conferences. He is a 2009 IEEE Fellow.



### NEXT-GENERATION SURGERY SYSTEMS

#### H. HARRY ASADA, PHD

Massachusetts Institute of Technology

H. Harry Asada, PhD, is the Ford Professor of Engineering, Director of the Brit and Alex d'Arbeloff Laboratory for Information Systems and Technology, and head of Control, Instrumentation, and Robotics at the Massachusetts Institute of Technology.

Asada's research interests include robotics, biomedical engineering, dynamic systems and control, information technology, design, and manufacturing. In 1981, he invented Direct-Drive Robots, which have been used for clean-room automation and assembly. He has also developed a number of innovative devices for robotics and biomedical applications, including fingernail sensors for measuring fingertip forces and finger posture without covering the fingertips, holonomic ball-wheel vehicles for omni-directional wheelchairs, the MIT Ring wearable sensor for continuous health monitoring, and cellular muscle actuators.

Asada has been the recipient of several awards and honors recognizing his research and teaching efforts, including the ASME Rufus Oldenburger Medal, the Ruth and Joel Spira Award for Distinguished Teaching, and the Henry Paynter Outstanding Researcher Award. He is also a fellow of the American Society of Mechanical Engineers.

## SESSION 3: ROBOTICS IN PRACTICE: REALIZING CLINICALLY MEANINGFUL ADVANCES



### CHALLENGES IN ROBOTIC COLORECTAL SURGERY

#### DEBORAH A. NAGLE, MD

Beth Israel Deaconess Medical Center/Harvard

Deborah A. Nagle, MD, is Chief of Colon and Rectal Surgery at Beth Israel Medical Center and Assistant Professor of Surgery at Harvard Medical School.

Nagle's clinical interests include laparoscopic and robotic surgery for colon and rectal cancer, diverticular disease, ulcerative colitis, Crohn's disease, and colon polyps. Nagle is nationally recognized for her specialty expertise and vast experience in minimally invasive approaches to treating rectal cancer, colon cancer, and other disorders.

Nagle introduced, developed, and continues to promote the use of minimally invasive colorectal surgical techniques. She was part of the team that developed the port of single incision laparoscopic surgery and began the first robotic colon and rectal surgery program in Massachusetts.



### BARRIERS TO THORACIC SURGERY

#### PATRICK ROSS JR. MD, PHD

Ohio State University



Patrick Ross Jr., MD, PhD, is Chief of Thoracic Surgery and Professor of Surgery at Ohio State University Medical Center. He is Chief of Staff at Ohio State University Comprehensive Cancer Center's Arthur G. James Cancer Hospital and Richard J. Solove Research Institute, and a member of the Commission on Cancer.

Ross' interests include thoracic surgical oncology, minimally invasive surgery, robotic surgery, photodynamic therapy, and lung volume reduction surgery. His research focuses on outcomes studies in thoracic oncology and new modalities in lung cancer care.

His research has been published in the *American Journal of Respiratory and Critical Care Medicine*, the *Journal of Heart and Lung Transplantation*, and *Lasers in Medicine and Surgery*. He is a member of the American College of Surgeons, Society of Surgical Oncology, International Association for the Study of Lung Cancer, and the International Photodynamic Association.



### CRITICAL REQUIREMENTS IN ROBOTIC CANCER SURGERY

#### YUMAN FONG, MD

City of Hope National Medical Center

Yuman Fong, MD, was recently appointed Chair of Surgery at City of Hope National Medical Center in Duarte, CA. Previously, he served as the Murray F. Brennan Chair in Surgery at Memorial Sloan Kettering Cancer Center and Professor of Surgery at Weill Cornell Medical College.

Fong is an internationally recognized expert in hepatobiliary cancer and in the use of genetically modified viruses to combat malignant disease. A specialist in cancers of the liver, bile duct, gallbladder, and pancreas, Fong has pioneered many surgical, laparoscopic, robotic, and ablative therapies for these cancers. Nationally and internationally, he has been involved in studies aimed at understanding, treating, and preventing these cancers, and in developing widely applicable and minimally invasive technologies for their treatment.

He has received grant support continuously over the past 17 years, mostly from the NIH; has been awarded five patents related to his work; and recently finished a two-year term as chair of the recombinant DNA advisory committee of NIH. Fong has received numerous honors and awards, including the Franklin Martin Faculty Fellowship from the American College of Surgeons, and the Shipley Award from the Southern Surgical Association.

## ROBOTIC-SURGEON INTERFACE

### **INSTRUMENT TRACKING AND VISUALIZATION FOR ULTRASOUND CATHETER GUIDED PROCEDURES**

Laura J. Brattain<sup>1</sup>, Paul M. Loschak<sup>1</sup>, Cory M. Tschabrunn<sup>2</sup>, Elad Anter<sup>2</sup>, and Robert D. Howe<sup>1</sup>

<sup>1</sup> Harvard School of Engineering and Applied Sciences;

<sup>2</sup> Harvard-Thorndike Electrophysiology Institute, Beth Israel Deaconess Medical Center

### **SURGISKINS - LIVE. REMOTE SURGICAL TELEMENTORING WITH MULTI-SENSORY ANNOTATED TELESTRATION**

James Smurro<sup>1</sup> and G. Anthony Reina<sup>2</sup>

<sup>1</sup> Foresight Imaging LLC;

<sup>2</sup> SkySurgery LLC

### **VIDEO BASED SAFETY ENHANCEMENT AND SEMANTICS IDENTIFICATION FOR ROBOTIC SURGERIES**

Madusudanan Sathianarayanan<sup>1</sup>, Suren Kumar<sup>1</sup>, Sudha Garimella<sup>1</sup>, Pankaj Singhal<sup>2</sup>, Jason J. Corso<sup>1</sup> and Venkat Krovi<sup>1</sup>

<sup>1</sup> SUNY Buffalo;

<sup>2</sup> Kaleida Health Systems (WNY)

### **THE EFFECT OF ROBOTIC MANIPULATION ON MOVEMENT KINEMATICS AND VARIABILITY IN EXPERIENCED SURGEONS AND NOVICE USERS OF A DA VINCI SI SYSTEM**

Ilana Nisky<sup>1</sup>, Michael H. Hsieh<sup>2</sup>, and Allison M. Okamura<sup>1</sup>

<sup>1</sup> Department of Mechanical Engineering, Stanford University

<sup>2</sup> Department of Urology, Stanford University

## HUMAN-MACHINE REPLACEMENT AND ASSISTIVE BIOPROSTHETICS

### **SURGICAL MOTION CHARACTERIZATION FOR ROBOTIC DEVICE DESIGN AND SURGICAL PERFORMANCE ASSESSMENT**

Frank L. Hammond III<sup>1</sup>, Simon G. Talbot<sup>2</sup>, Robert J. Wood<sup>1</sup>, and Robert D. Howe<sup>1</sup>

<sup>1</sup> Harvard School of Engineering and Applied Science;

<sup>2</sup> Harvard Medical School and Brigham and Women's Hospital

### **A SOFT EXOSUIT FOR GAIT ASSISTANCE**

Stefano M. M. De Rossi<sup>1,2</sup>, Kathleen O'Donnell<sup>1,2</sup>, Alan T. Asbeck<sup>1,2</sup>, Ye Ding<sup>1,2</sup>, Ignacio Galiana<sup>1,2</sup>, Jaehyun Bae<sup>1,2</sup>, Kenneth G. Holt<sup>3</sup>, and Conor J. Walsh<sup>1,2</sup>

<sup>1</sup> Harvard School of Engineering and Applied Science;

<sup>2</sup> Wyss Institute for Biologically Inspired Engineering, Harvard University;

<sup>3</sup> Department of Physical Therapy and Athletic Training, Boston University

### **DEVELOPMENT OF SHARED DESIGN RESOURCES FOR MEDICAL APPLICATIONS OF SOFT ROBOTICS**

Panagiotis Polygerinos<sup>1,2</sup>, Donal Holland<sup>1</sup>, Evelyn Park<sup>1</sup>, Zheng Wang<sup>1,2</sup>, Kevin Galloway<sup>2</sup>, Bas Overvelde<sup>1</sup>, Robert Wood<sup>1,2</sup>, Katia Bertoldi<sup>1</sup> and Conor Walsh<sup>1,2</sup>

<sup>1</sup> Harvard School of Engineering and Applied Sciences;

<sup>2</sup> Wyss Institute for Biologically Inspired Engineering, Harvard University

## ROBOTICS IN SURGICAL PRACTICE

### POPOP MEDICAL DEVICES: FROM SENSING FORCES TO TREATING PAIN

Samuel B. Kesner<sup>1</sup>, Joshua Gafford<sup>2</sup>, Kathleen O'Donnell<sup>1</sup>, Zivthan Dubrovsky<sup>1</sup>, Robert J. Wood<sup>1,2</sup>, and Conor J. Walsh<sup>1,2</sup>

<sup>1</sup> Wyss Institute for Biologically Inspired Engineering, Harvard University;

<sup>2</sup> Harvard School of Engineering and Applied Sciences

### TRAINING SURGEONS IN ROBOTICS

Melissa E. Hogg, Amer H. Zureikat, David L. Bartlett, and Herb J. Zeh III

University of Pittsburgh Medical Center

### THE ROLE OF OBESITY IN ROBOTIC MITRAL VALVE SURGERY: A SINGLE CENTER EXPERIENCE

Thomas M. Kelley, Kashem Mohammed, Jim McCarthy, Sheela Pai, Yanfu Shao, Yoshiya Toyoda, and T. Sloane Guy  
Department of Cardiovascular Surgery, Temple University Hospital

### A TEST PLATFORM FOR AUTONOMOUS CAMERA CONTROL FOR LAPAROSCOPIC SURGERY

Brady W. King<sup>1</sup>, Luke A. Reisner<sup>2</sup>, Abhilash K. Pandya<sup>2</sup>, Anthony M. Composto<sup>2</sup>, R. Darin Ellis<sup>3</sup>, and Michael D. Klein<sup>1</sup>

<sup>1</sup> Department of Pediatric Surgery, Children's Hospital of Michigan

<sup>2</sup> Department of Electrical and Computer Engineering, Wayne State University

<sup>3</sup> Department of Industrial and Systems Engineering, Wayne State University

### NOVEL USE OF INDOCYANINE GREEN AND NEAR-INFRARED FLUORESCENCE IMAGING DURING ROBOT-ASSISTED URETEROURETEROSTOMY: INITIAL CLINICAL EXPERIENCE

Ziho Lee, Laura Giusto, Blake W. Moore, Jack H. Mydlo, and Daniel D. Eun

Department of Urology, Temple University School of Medicine

### AUTOMATED POINTING OF CARDIAC IMAGING CATHETERS

Paul M. Loschak<sup>1</sup>, Laura J. Brattain<sup>1</sup>, Cory M. Tschabrunn<sup>2</sup>, Elad Anter<sup>2</sup>, and Robert D. Howe<sup>1</sup>

<sup>1</sup> Harvard School of Engineering and Applied Sciences

<sup>2</sup> Beth Israel Deaconess Medical Center

### LESSONS LEARNED THROUGH TEAMWORK: SAFE IMPLEMENTATION OF A NEW ROBOTIC HPB SURGERY PROGRAM

Wald van der Vliet, Stijn Thoolen, Melissa Jones, Elena Canacari, Elliot Chaikof, Peter Panzica, Ammara Abbasi, Lorenzo Anez-Bustillos, Jennifer F. Tseng, Mark P. Callery, Tara S. Kent, and A.J. Moser

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